Vol. 53 No. 4

BULLETIN

OF THE

TORREY BOTANICAL CLUB

APRIL 1926

The specific electrical conductivity of the leaf tissue fluids of phanerogamic epiphytes

J. Arthur Harris

I. INTRODUCTORY

It has frequently been suggested that the specific electrical conductivity of organic fluids should furnish a satisfactory measure of their content of salts and acids. Practically, however, there are many difficulties to be overcome before such data determined in the course of physiological and ecological work can be fully interpreted. They have, nevertheless, much value when comparatively treated, and have been used in a number of investigations. It should be evident that in ecological work, for example, a knowledge of the electrical conductivity of the tissue fluids of halophytes should furnish information of much value when considered in comparison with that of the plant species of non-saline areas and of plants of transitional habitats. The value of such data will necessarily become greater as the number of series available for comparison becomes larger.

Among the problems which might seem of outstanding interest is that of the electrical conductivity of the tissue fluids of epiphytes as compared with those of terrestrial species.

In an earlier paper (*1*)[1] I have shown that the osmotic concentration of the tissue fluids of phanerogamic epiphytes is generally very much lower than that of terrestrial plants. Under the conditions available for the first investigation it was impracticable to determine physicochemical constants other than osmotic concentration. The primary purpose of the present paper is to give the results of a series of conductivity measurements made in 1923 on epiphytic flowering plants from the hammocks of Southern Florida.

[1] Reference is made by number (italic) to "Literature cited," p. 187.

[The Bulletin for March (**53**: 129–182) was issued 1 April, 1926.]

II. METHODS

The methods are those employed in a series of investigations on the physicochemical properties of plant tissue fluids, and need not be discussed in detail other than to say that specific electrical conductivity was determined in a Freas cell, standardized against N/10 KCl, taken to have a conductivity of 0.01412 mho at 30°, after centrifugation and the determination of osmotic concentration by the cryoscopic method, on sap expressed after freezing the tissue in an ice-salt mixture.

III. PRESENTATION AND ANALYSIS OF DATA

The values of osmotic concentration (in terms of both the corrected freezing point depression, Δ, and in atmospheres, P) specific electrical conductivity in reciprocal ohms, K, and the ratio of conductivity to freezing point depression, K/Δ, are given in the accompanying TABLE I.

The determinations on the practically leafless species of *Vanilla* were made on the fluids of the succulent stems. All others were based on the leaf tissue fluids.

The values of osmotic concentration are uniformly low, and serve to confirm the conclusions drawn from earlier investigations. The electrical conductivities are more variable in magnitude. Of the 22 values, 14 show a conductivity less than 0.010 reciprocal ohms, 6 show a conductivity less than 0.015 reciprocal ohms, and the remaining 2 are characterized by a conductivity of less than 0.020 reciprocal ohms.

Comparing these values among themselves, we may note that the lowest conductivities are those of the fluids from the succulent stems of the *Vanilla*. These are only about half as large as those found in the leaves of the other epiphytes, and are among the lowest conductivities of plant tissue fluids reported.

In general, the Bromeliaceae have a higher electrical conductivity than the Orchidaceae or Piperaceae. This may, however, be due in part to environmental factors. A number of the bromeliads were taken in mangrove swamps where there was doubtless an occasional opportunity for the absorption of salts from wind-borne spray, whereas the orchids came mainly from points more distant from salt waters.

In the case of *Tillandsia fasciculata*, C2366, in which K = 0.0180, was taken from a mangrove swamp on the shores of

the saline waters of Biscayne Bay, whereas C23155, in which K = 0.0100 only, was taken from a mangrove swamp growing under essentially fresh water conditions in the Jupiter River. The only available conductivities for *T. utriculata* (C2364) and *T. aloifolia* (C2367), in which K = 0.0169 and 0.0115 respectively, were based on plants growing in association with the *T. fasciculata* mentioned above (C2366) along the saline waters of Biscayne Bay.

The conductivities of these forms from the saline mangrove swamp are higher than those of *T. tenuifolia* (C2351) and *T. fasciculata* (C23155) from habitats more distant from the sea.

The 16 determinations on orchids are with three exceptions less than 0.010 reciprocal ohms. The highest value (K=0.0117 for C2365, *Encyclia tampense*) is based on materials taken in association with *T. fasciculata* (C2366), *T. utriculata* (C2364) and *T. aloifolia* (C2367) in the saline mangrove swamp.

The suggestion of a definite relationship between the salinity of the tissue fluids of the epiphytic vegetation is enough to justify the undertaking of more detailed comparisons between ecologically different habitats.

Turning now to a comparison of these conductivities with those which are available in published form for terrestrial plants, we may note that, while they are low as compared with the values found in saline habitats such as the *Kochia* association, the Shadscale association, the Greasewood-Shadscale association, and the more saline Grass-Flat and Salt-Flat associations of the Great Basin (*3*), they are lower than those found in mistletoes of the Southern Arizona region (*11*), and lower than that of *Cuscuta* parasitic on a halophyte, *Allenrolfea occidentalis* (*2*). They are also lower than those for the cottons cultivated on saline soils (*10*, *8*), as might logically be expected from the high chloride (*9*) and sulphate (*7*) content of the latter.

The values are, however, not so small as might perhaps have been anticipated for plants growing without immediate contact with the soil. The higher constants are of the same general order of magnitude as many of the species of the Stansbury Mountains at higher elevations (*3*). They are of the same general order of magnitude as the conductivities of an extensive series of determinations on such trees as *Acer*, *Betula*, *Fagus*, *Juglans*, *Gleditsia*, *Platanus*, *Quercus*, *Robinia* and *Salix* as determined on samples collected at various levels (*6*) on Long Island.

TABLE I.

Species	Collection number	Date	Depression of freezing point Δ	Osmotic concentration in atmospheres, P	Specific electrical conductivity K	Ratio, conductivity to depression K/Δ	Notes
BROMELIACEAE							
Tillandsia tenuifolia L.	C 2351	Jan. 17	.43	5.1	.0093	.0219	In Royal Palm Hammock
" fasciculata Sw.	C 2366	" 21	.61	7.3	.0180	.0297	In mangrove swamp, on shore of Biscayne Bay
" " "	C23155	Feb. 8	.43	5.2	.0100	.0232	In mangrove swamp, on island in Jupiter River
" utriculata L.	C 2364	Jan. 21	.66	8.0	.0169	.0256	In mangrove swamp, on shore of Biscayne Bay
" aloifolia Hook.	C 2367	" "	.55	6.7	.0115	.0207	In mangrove swamp, on shore of Biscayne Bay
ORCHIDACEAE							
Vanilla	C23204	Mar. 1	.46	5.6	.0054	.0116	In dwarfed mangrove swamp, near Bay of Florida
"	C23358	Apr. 13	.45	5.4	.0056	.0126	In dwarfed mangrove swamp, near Bay of Florida
Macradenia lutescens R. Br.	C 2341	Jan. 17	.43	5.2	.0068	.0158	In Royal Palm Hammock
Oncidium undulatum (Sw.) Salisb.	C23353	Apr. 14	.34	4.1	.0079	.0229	In *Conocarpus* swamp, near Bay of Florida
Epidendrum cochleatum L.	C 2342	Jan. 17	.42	5.1	.0080	.0190	In Royal Palm Hammock
" " "	C23125	Feb. 2	.45	5.4	.0111	.0250	In a Pineland Hammock
" " "	C23148	" 8	.42	5.2	.0090	.0210	In wooded swamp, at Headwaters of Jupiter River
" " "	C23186	Mar. 1	.46	5.5	.0105	.0228	In *Conocarpus* swamp near Bay of Florida
Spathiger rigidus (Jacq.) Small	C 2356	Jan. 17	.38	4.6	.0093	.0244	In Royal Palm Hammock
" " " "	C23147	Feb. 8	.32	3.9	.0070	.0219	In wooded swamp, Headwaters of Jupiter River
" " " "	C23302	Apr. 4	.31	3.7	.0076	.0250	In wooded swamp, Headwaters of Jupiter River
Encyclia tampense (Lindl.) Small	C23107	Jan. 24	.45	5.4	.0092	.0206	In mangrove swamp, on Island in Jupiter River
" " " "	C 2365	" 21	.64	7.7	.0117	.0183	In mangrove swamp, on shore of Biscayne Bay
" " " "	C23149	Feb. 8	.65	7.8	.0091	.0141	In wooded swamp, Headwaters of Jupiter River
Auliza nocturna (L.) Small	C23183	Mar. 1	.51	6.2	.0090	.0177	In mangrove swamp, near Bay of Florida
" " " "	C23350	Apr. 13	.38	4.6	.0096	.0249	In mangrove swamp, near Bay of Florida
PIPERACEAE							
Peperomia obtusifolia (L.) Dietr.	C22938	Dec. 14	.46	5.5	.0126	.0273	In Royal Palm Hammock

Remembering that the tissue fluids of ligneous and herbaceous plants are differentiated with respect to their electrical conductivity (*4*), we may properly compare these with a series of determinations on herbaceous plants (*5*) from Long Island.[2] We may note that the average value of K for a series of 162 species of herbs is 0.014308. Examination of the individual constants shows that a number of the species have tissue fluids of as low conductivity as that found in the epiphytes.

IV. SUMMARY

The osmotic concentration and specific electrical conductivity of the tissue fluids of a number of phanerogamic epiphytes from the subtropical habitats of southern Florida have been determined.

The low values of osmotic concentration are in excellent agreement with earlier series from Florida and from Jamaica, British West Indies.

The specific electrical conductivities are variable. This is apparently due to the fact that some of the species were under the influence of the greater salinity of strand conditions.

While the conductivities are far lower than those of terrestrial species in saline regions, they are of the same general order of magnitude as the lower values of herbaceous forms in non-saline regions. It is clear, therefore, that the tissue fluids of epiphytic plants are by no means poor in conducting solutes.

Literature cited

(1) **Harris, J. Arthur.** On the osmotic concentration of the tissue fluids of phanerogamic epiphytes. Am. Jour. Bot. **5:** 490–506. 1918.

(2) ———. The tissue fluids of *Cuscuta*. Bull. Torrey Club **51:** 127–131. 1924.

(3) ———, **R. A. Gortner, W. F. Hoffman, J. V. Lawrence, & A. T. Valentine.** The osmotic concentration, specific electrical conductivity and chlorid content of the tissue fluids of the indicator plants of Tooele Valley, Utah. Jour. Agr. Res. **27:** 893–924. 1924.

(4) ———, **R. A. Gortner, & J. V. Lawrence.** On the differentiation of the leaf tissue fluids of ligneous and herbaceous plants with respect to osmotic concentration and electrical conductivity. Jour. Gen. Phys. **3:** 343–345. 1921.

[2] The series is used because determinations from subtropical habitats are not yet available in published form.

(5) ———, **R. A. Gortner, & J. V. Lawrence.** The osmotic concentration and electrical conductivity of the tissue fluids of ligneous and herbaceous plants. Jour. Phys. Chem. **25:** 122–146. 1921.

(6) ———, **R. A. Gortner, & J. V. Lawrence.** The relationship between the osmotic concentration of leaf sap and the height of leaf insertion in trees. Bull. Torrey Club **44:** 267–286. 1917.

(7) ———, **C. T. Hoffman, & W. F. Hoffman.** Sulphate content of the leaf-tissue fluids of Egyptian and Upland cotton. Jour. Agr. Res. **31:** 653–661. 1925.

(8) ———, **W. F. Hoffman, W. B. Sinclair, A. H. Johnson, & R. D. Evans.** The leaf tissue fluids of Egyptian cottons. Jour. Agr. Res. **31:** 1027–1033. 1926.

(9) ———, **J. V. Lawrence, & Z. W. Lawrence.** The chlorid content of the leaf tissue fluids of Egyptian and Upland cotton. Jour. Agr. Res. **28:** 695–704. 1924.

(10) ———, **Z. W. Lawrence, W. F. Hoffman, J. V. Lawrence, & A. T. Valentine.** The tissue fluids of Egyptian and Upland cottons and their F_1 hybrid. Jour. Agr. Res. **27:** 267–328. *pl. 1.* 1924.

(11) ———, **& A. T. Valentine.** The specific electrical conductivity of the tissue fluids of desert Loranthaceae. Proc. Soc. Exp. Biol. Med. **18:** 95–97. 1920.

The nature and cause of secondary sexual states with special reference to Typha[1]

JOHN H. SCHAFFNER

Any sexual condition developed in the individual usually exhibits great stability, and when sex reversal is induced we are very greatly impressed with the peculiarity of the phenomenon. Yet, if a man were acquainted only with hemp grown in a nine-hour daylight period and then were suddenly transported to a region where it was raised in a fifteen-hour daylight period, he would be just as much surprised at the apparent change from a condition of sexual instability to the very fixed condition and segregation of maleness and femaleness exhibited in the new environment.

Because of the usual stability of unisexual individuals, there has been a more or less tacit assumption among biologists that the persistency of a given sexual state must be an adequate basis for a differential factorial explanation of that duality of form and function which we call male and female. The apparent predisposition, either in the young or mature individual, toward one sex or the other, the seeming fixity commonly present and the frequent inability of the experimenter, hitherto, to produce reversals of the sexual state at will, have appeared to many to be conclusive indications of a specific and particular condition of allelomorphic hereditary factors, either of a simple or multiple nature.

But just as unisexuality has its antecedent in hermaphroditism, so has persistency of structure and function, as postulated in our theories of heredity, its counterpart in the persistency of structure and function of differentiated tissues and organs coming from a common source and whose complement of hereditary potentialities are known to be absolutely the same. It is quite well known that we have made less progress in dedifferentiation, in undoing the results of differentiation of highly specialized

[1] Papers from the Department of Botany, The Ohio State University, no. 163.

Invitation paper read at the joint meeting of Section G (Botanical Sciences) American Association for the Advancement of Science, the Botanical Society of America, the American Phytopathological Society, and the American Society of Plant Physiologists at Kansas City, Mo., 29 December 1925.

organs, than in the changing of sexual states or inducing sex reversals. It is this view, that persistency of sexual states is due to differentiation processes of the same nature as other differentiation processes and not to differential hereditary factor systems, that is the text of the present discussion.

We are all aware of the stability in the development of roots and shoots. In a very early stage of the embryo an incipient shoot bud and an incipient root bud are organized and in the simpler cases the root has not only a very profound difference of form, structure, and chemical content from the shoot but the two systems have an entirely opposite reaction to the physical environment, the root growing and turning in the direction of gravity and the shoot against it. This property, continuing, places the two parts into two extreme environments, soil and darkness, etc., on the one hand and air and daylight on the other. Now these two conditions are persistent and stable, the root producing more root with the same characteristics and properties and the shoot producing its same characteristics and properties. What is the cause of this persistency of character and action which continues the remarkable dimorphism? The answer is obvious. It does not result from a difference in potentiality of the cells, in other words a difference of heredity in the two parts, but is due entirely to the course of differentiation starting in the embryo and not changing in the meantime, nor do we expect it to change unless we produce a proper alteration in the environment. By such a change of environment the root in many species immediately begins to produce the complete and normal shoot and the shoot in the same way begins to produce root. Not only are morphological expressions thus stable but the same conditions of fixity are to be seen in differentiated functional systems. Certain organs are differentiated and continue to produce the same materials and reactions so long as the plant or animal lives. The liver continues to secrete bile, the base of the fingernail keeps on producing more fingernail, not because the two sets of cells have different potentialities—they have received the same common heredity—but because of the fact that they have become differentiated in these functions during the early ontogenetic development through the guidance of physiological and growth gradients.

The process of differentiation may also acquire a stability

which persists only for a time and suddenly changes to another type. For example, the persistency of dwarf branch and long branch in *Ginkgo* may be considered. For many years, through cold and heat, dry season and wet season, a bud will continue to produce a dwarf branch, characterized by the absence of internodes and functional axillary buds, yet suddenly through some internal cause it will begin to develop as a long shoot with long internodes and well developed axillary buds. Sooner or later the factors inducing dwarf-branch characters will again come into play. Some dwarf branches, however, may continue their development for years and finally die without a change. We can then say that this special bud was "permanently determined" since it showed a constancy during its entire ontogeny, yet we know that a little manipulation would have brought about a change to the long branch condition. Just so, we say that a plant is "permanently male or female" if it shows no sex reversal before its death.

It has become evident from various experiments on the higher plants that there is no direct relation between unisexuality or monosporangiateness of the individual and fixity of the sexual state on the one hand, and hermaphroditism or bisporangiateness of the individual and modifiability on the other; nor is there any relation between extreme sexual dimorphism and stability. As shown by experiments on the extremely dimorphic hemp, sex reversal is often more easily induced than in species much less dimorphic. The progression of the development of sexual states with the accompanying morphological expression normally follows in an almost invariable order in the developing floral axis of bisporangiate flowers, as in a *Magnolia* where a broad zone of stamens is developed first, followed, through a reversal of the sexual state, by a broad zone of carpels. Bisporangiate species are then also decidedly fixed as to the sequence of sexual expressions and persistency of sexual states within the limits of their ontogeny. However, experiments on monecious species especially are needed and promise important results, judging from what may be learned by direct observations and from the experiments so far conducted on the partly monecious *Arisaema Dracontium*, in which monecious individuals can be changed to the pure staminate condition and vice versa. In any event, a most favorable starting point for the study of the origin and

stability of sexual states in the ontogenetic cycle can be found in those types of monecious plants in which first one sexual state is established in a determinate inflorescence bud to be followed later through sex reversal to the opposite state, a very uniform sequence of expression being present because of a terminating physiological gradient. In such cases the sexual states and expressions can be followed out more clearly because it is known beforehand that they all come from a common hereditary potentiality. In this way we can discover whether there is any fundamental difference in the nature of sex determination between those organisms which are unisexual and so may have a differential heredity and those which are bisexual or hermaphrodite.

The two species of *Typha* were selected for special study in this respect. Although only field observations have been made so far, they nevertheless appear to offer very important evidence. In both species the carpellate inflorescence is normally below and the staminate above, both types of flowers being greatly reduced and developed in great numbers directly from the inflorescence axis which is a continuation of the aerial leafy shoot. The two species, *T. latifolia* and *T. angustifolia*, are essentially alike in their sexual expression, both normal and abnormal, except that the first usually has the carpellate and staminate parts in close proximity or contiguous, while the latter usually has a short stem between the two. This distinction, however, often breaks down; *T. latifolia* may have a long stem between the two parts and in *T. angustifolia* the two may be contiguous. The carpellate and staminate zones of the inflorescence are usually about equal in length. The normal development of the axis is, therefore, for the bud, as it approaches determinate growth, to pass to the female condition and to develop a wide zone of carpellate flowers and then, after passing through a neutral condition for a greater or lesser period of time, to reverse completely to the male condition which continues until growth is ended. There are, however, variations from this general type. In some cases a tiny patch or zone of carpellate flowers is first produced, followed by a long neutral stem which finally ends in a staminate inflorescence. Quite frequently stalks develop with a purely staminate inflorescence, no femaleness whatever being expressed. When reproduction begins, the bud passes over to the male state and continues thus to the end of development. This condition has been

observed in Maine and Ohio and especially in northern Michigan, Wisconsin and Minnesota. These purely staminate shoots arise side by side with the normal monecious shoots with carpellate flowers below and staminate above. In these cases of purely staminate inflorescences, the functional gradient is the same in the growing bud at the beginning of floral development as it is in the normal type of inflorescence only after passing through the female condition and then back through neutral to the staminate expression.

Although there is sometimes a great difference in the comparative lengths of the carpellate and staminate parts, and as intimated all gradations can be found to the complete absence of femaleness, so far no case has been observed in which the entire inflorescence was carpellate. A few specimens have been collected in which the lower carpellate part was very long and the upper staminate part very short. Sometimes the female state continues until a foot or more of carpellate inflorescence has been developed. It would probably require a very extreme and extraordinary condition to keep the female state intact until the end of determination. However, it is possible that such a condition may occasionally arise in view of certain extraordinary facts presented below.

In some cases inflorescences are developed in which a bud is thrown into the male state on one side and the female state on the other, or several alternating segments may show alternating sexual states. In such cases, since the sexual states are persistent for some time, vertical strips or bands of carpellate and staminate flowers will be produced. These inflorescences then appear like sectorial chimeras; but while chimeras are produced by the peculiar arrangements of different species of cells with different heredities, these chimera-like inflorescences are developed from cells with a common heredity but with different, persistent sexual states. However, at the proper level the cells in the female condition will be reversed to the male state and the upper part of the inflorescence thus becomes normally staminate. In some cases only a very small group of cells will be in the male state at first and these will give rise to a very narrow strip of staminate flowers in the carpellate inflorescence. In still other cases, when flower development begins, a minute group of cells of the developing inflorescence bud will be thrown into the male state and begin to

produce staminate flowers, while the greater part is in the female state and producing carpellate flowers, and the area of the bud in which the cells are in the male state will gradually increase until the entire bud is finally in the male state. In other words, there is a gradual spreading of the area of sex reversal. In such an inflorescence the lower part will be carpellate and the upper staminate with a long diagonal plane separating the contiguous female and male parts.

In inflorescences with three internodes or divisions, it frequently happens that the lowest internode is entirely carpellate, the middle node is carpellate on one side and staminate on the other, the one vertical band of flowers being wide and the other narrow or both being of about the same width, while the uppermost internode is entirely staminate.

In all these cases the progress and persistency of expression is from carpellate to staminate, and when the staminate condition is attained it persists to the end of determination. There is a definite progression of events just as in morphological differentiations where sex is not involved. But just as sex reversal is possible and easily induced in various diecious species, and as the differentiation progression or the differentiated cells can be dedifferentiated (as is the case in hemp, where three or four rejuvenations are possible and three or four differentiation cycles, of the same nature as the first one that had its inception in the seed, may be passed through) so it must be possible for the physiological states and gradients in the *Typha* to vary in respect to sexual differentiations and so induce reversals of the sexual states other than those that the normal cycle indicates and thus give reversed arrangements in the succession of carpellate and staminate flowers. The degree or extent of such changed expressions will depend on the specific hereditary constitution and the fitness and intensity of the environmental conditions which can bring such changes about. So far not many aberrant examples of this nature have been found. No case has been seen in which the inflorescence was staminate at the base and carpellate above. Whenever male determination took place at the base of the inflorescence it continued to the end of development. One type of reversal from maleness to femaleness is, however, rather common, and was first called to my attention by a former Chinese student, Mr. C. K. Kao. An inflorescence with a normal carpel-

late zone below and a staminate zone above may reverse at the very tip and develop carpels again. Commonly, these carpellate flowers, although they have stigmas, have imperfect ovularies. A few cases were found, however, where the carpellate development covered a half inch or more of the tip and appeared to have some perfect or nearly perfect carpels. More interesting were three shoots of *Typha latifolia*, found in Northern Michigan, which had the normal, basal carpellate zone and the normal reversal to the staminate condition near the middle of the inflorescence and then, after about an inch of growth, had reversals to femaleness, developing patches of normal carpellate flowers again. In one of these a neutral area began to appear about an inch above the base of the staminate zone on one side, which soon changed to a normal female tissue with normal carpels. The neutral area was covered with papillae which gradually merged through imperfect to perfect carpellate flowers. The other two inflorescences each had two oblong patches of perfectly developed carpellate flowers on opposite sides within the staminate zone, beginning at somewhat different levels but both terminating rather abruptly through a reversal to the staminate condition again. Here then, beginning at the base of vertical bands of the inflorescence, certain groups of cells of the inflorescence bud reversed their sexual states in their cell lineage from neutral, to female, to male, to female, to male; or in the first example cited from neutral to female, to male, to neutral, to female, to male. Although we have in this case temporary stability at each stage, the group of cells in question nevertheless passed through three sex reversals rather than one, as is the normal condition. There can be no question but that with proper investigations such changes could be produced at will in the monecious *Typha* as readily as they have been brought about in the diecious *Cannabis* and other diecious species.

In the observations just given, we have the very same phenomena of stability and instability of sexual states in a monecious plant as those which have been produced in the diecious *Cannabis sativa* without allosomes, and the diecious *Lupulus japonicus* with allosomes; in both of which there is a normal condition of stability under the usual environment but instability accompanied by abundant sex reversal in unusual environments, either during the original ontogenetic cycle of the plant or, in cases of repeated rejuvenations, in a subsequent cycle of development.

Now it must be emphasized that in all such cases which involve reversals and rereversals of sexual states and expressions in monecious species, we know that we are not dealing with different hereditary constitutions or changes in such constitutions but merely with functional states and physiological gradients and with plus (+) and minus (—) states, which are responsible for the activity and latency, or for a peculiar mode of control or reaction, of the herditary factors present in the complex. The persistency of a given sexual state is then of the same nature, and caused in the same way as the persistency of any ordinary vegetative differentiation, and the change from one sexual state to the other is brought about in the same way as a change in vegetative expression is brought about, through the operation of the usual ontogenetic gradients, or in case of rejuvenation by new gradients induced by environment.

From the experiments on reversals in diecious species and observations on the sharply bounded limits of male and female tissues, it appears that in plants there are no hormones produced which are readily diffusible from one cell to the other. If such substances are produced in relation to the sexual conditions, they must either be developed so constantly and in such quantity as to be able to neutralize any material coming through from a region of the opposite sexual condition, or else the peculiar character of the plant cell wall offers a very decisive barrier to the passage of such substances. It is now known that cell walls of the higher plants usually contain layers of pectose as well as cellulose, and pectic walls are known to be differentially permeable to certain substances. In some of the higher animals such hormones as are produced in the sex glands appear to circulate through the body and to be readily diffusible through the animal cell wall. Thus, in many animals at least, not only the sexual state but the differentiated tissues become unstable and reverse their sex whenever the opposite hormone is introduced into the system in suitable quantity. The transformation is sometimes so extreme that it is difficult to determine the original sexual state of the animal unless the allosome condition were studied which presumably should not undergo a transformation. But hormones produced by the sex glands are not the primary cause of sexual states. They are the results of such states but they are of such a nature, nevertheless, that their presence is a

proper environment to produce sexual expression, determination, or reversal.

It is important to remember that just as sex reversals are brought about in monecious species in apparently the same external environments, so reciprocal reversals—male to female and female to male—occur and are induced in exactly the same external environments, so far as one can see, in diecious plants when they are growing side by side, as is the case with hemp and Japanese hop. But the physiological gradients and conditions in the different individuals and in different parts of the same plant are necessarily different at practically all times. So if we originally get equal numbers of males and females of the common hemp in a common environment, this is no more an argument in itself for the hypothesis that the result is due to a difference of heredities than the fact that through the influence of a common environment we get reciprocal sex reversals; for this in itself shows that the two individuals were exactly similar in so far as sex potentialities are concerned.

We must not confuse sexual characters with sexuality itself or the sexual state. For sexuality is present in the lower forms without any expression of it in morphological characters. It is purely a functional state which manifests itself in isogamous gametes after their development is complete. Now if the time of origin of a sexual state is thrown back into the beginning of gametogenesis, there can be a difference in morphological expression. In the lowest heterogamous gametes this difference in character manifests itself then mainly as a difference in size. With the progression of evolution the hereditary complex of factors which may be influenced either by a primary or secondary sexual state in the cell becomes greater and results in greater dimorphisms.

Every unit sexual character is the result of the activity of a unit factor. But the expression of this factor, whether in relation to its activity or latency or the peculiar nature of the character itself, depends on the sexual state present at the time. And this state may be very fixed or very evanescent. The factors responsible for sex-limited characters will be segregated in the ordinary Mendelian fashion or according to any type of segregation and union taking place in the chromosome complement. But the determination of sexual states in itself is not a matter of

the presence or absence of a specific set of genes, since we know that the cell can change from one condition to another without a change in chromosome content. Now we do not at all deny that there are segregative factors that will change the functional activity of an organism or modify its gradient so that sexual changes of expression are advanced or retarded, up or down the developing axis, but the direct action on the sexual state is exactly the same as when sexual states are influenced through the environment. The environment produces a change in the physiological state which causes one or the other sexual state to be developed or reversed. It is on this account that environment may change the course of the expected sexual expression. The environment is not changing the nature of the fundamental potentialities responsible for a given sexual character.

Emerson has obtained mutants of Indian corn, which under ordinary conditions are entirely female, the terminal as well as the lateral inflorescence bearing carpellate flowers only, and hereditary factors have been found which when present in any constitution produce this condition. Now at first glance it might appear that here we have a true sex factor. But, as intimated, this factor may have nothing to do directly with sex but may be such as to affect the metabolism of the cell in a certain way in a given environment and this functional condition results in the development of a female state both on the side-ear branch and on the erect branch which terminates the growth of the shoot. From what we know of such conditions of sexuality, it appears probable that a special environment may be found which would act on the developing plant in such a way that a new gradient would be established in the terminal shoot which would not allow femaleness to develop in it or else would bring the physiological state to such a condition that reversal to maleness would come about at the base of the tassel or before the growth of the terminal inflorescence was ended. There are mutants of Indian corn in which the terminal stalk does develop femaleness and is partly modified to resemble the shank of an ear with partially developed husks and sometimes with little axillary ears, but the female state nevertheless disappears and the stalk ends in a pure staminate tassel or with carpellate structures developed only at the very base. If the ordinary types of Indian corn, which are monecious in the usual seasonal environ-

ment, are planted in the greenhouse during the short daylight period of winter, many individuals will show only female expression, producing carpellate inflorescences both at the side and at the tip or more commonly at the tip only. This is plainly due not to a lack of potentiality to produce the male state nor to a lack of any of the hereditary factors required for the expression of typical male characters but to the establishment of a new gradient of growth and function which causes reproduction to begin much earlier in the plant than when it is grown in the usual environment. The only difference I can see between the first and the third cases is that the first has one or more vegetative factors which have an influence on the functional activity, causing a different reaction in the same environment in respect to sex. This gradient and consequent reaction will not be the same in a different environment, and, since it seems quite certain that the carpellate corn plants have all the hereditary potentialities for male characters, the variety will show maleness whenever a suitable environment is found.

Now if one is still inclined to think that such factors should be called sex factors in the ordinary sense of the term, then the matter becomes merely a case of confusion of terminology, for it is evident that up to the present time the term gene or hereditary factor has had no such meaning. When we say we have a pair of allelomorphic factors for red and white pericarp, no breeding experiments have ever shown that after you have segregated the red and white you can still get the opposite characters out of the segregates as we can do in the case of male and female. The genes responsible for the carpellate Indian corn variety can be segregated out like any other Mendelian factor. The sex genes supposed to be responsible for sexual states are not so eliminated, for when the one is supposed to be segregated out of the system, as for example in the very popular "homozygous heterozygous formula," we can still take the supposed homozygous individual, which is presumed to have the homomorphic allosomes or the homozygous sex factors, and in many cases bring out the opposite sexual state. What was labelled "homo" has by some mysterious magic become "hetero."

That differentiation results in varying degrees of fixity is plainly shown by experiment. In the case of sexual differentiation, Mrs. Wuist Brown was able to induce changes of female

gametophytes of the ostrich fern up to 90 per cent, but the male gametophytes were much more fixed. With the treatment given, only 5 per cent showed reversal from maleness to femaleness. This agrees with the usual expectation since it is generally recognized that the male condition is a more extreme condition, when compared with the neutral vegetative state, than the female. In the diploid, highly dimorphic diecious hemp, however, no such difference in physiological stability is to be observed. The staminate plants show reversal to femaleness even more readily than the carpellate plants do to maleness, and usually much more promptly, when subject to exactly the same environments. We cannot then judge the degree of physiological differentiation or stability by the degree of morphological difference visible.

Czaja, in his experiments on regeneration from archegonial and antheridial tissues taken from the hermaphroditic gametophytes of homosporous ferns, found that the protonemata from archegonia can be made to develop both sexes and those from antheridia also, but it was quite difficult to produce the change in the plants which had originated from the male tissue. In these cases then, it is plain that the greater fixity present in the haploid male condition is not due to a difference in hereditary potentialities, since both have come through vegetative growth from a common haploid complement of chromosomes, but is dependent entirely on the differential processes of differentiation going on in the presence of the one or the other sexual state.

In species of *Oedogonium* with dwarf males it is known that the individual is haploid. The individual instead of producing male and female gametes, as in normal *Oedogonia*, produces eggs and the so-called androspores which are to be considered merely as parthenogenetic sperms. These are in the primary male state to a certain degree, at least, and are attracted by the eggs but instead of fertilizing the eggs they usually settle down on the base of the oogonium or on the cell below it and develop into a new filament, the dwarf male, which finally gives rise to functional spermatozoids. The dwarf male develops its peculiar morphology and persists in the male state not because it has a different complement of chromosomes or a different hereditary complex but entirely because of the fact that it is differentiated in a male state.

We well know that in the heterosporous plants, namely in all

higher plants, the sexual state which has been determined in the diploid sporophyte, or any part of it, is not changed in the passage over to the gametophyte but persists through the reduction, all four spores of the reduction showing the same sexual state. This is true whether the plant has bisporangiate flowers, whether it is monecious or diecious, whether it has allosomes or not. That there is occasionally a reversal in the sexual condition just before or after reduction is shown in such cases as reported by Chamberlain for *Salix*, where he found pollen grains inside of the ovules.

In case allosomes are present, if the carpellate plant is homozygous for allosomes and the staminate plant is heterozygous, the reduction division, although it segregates the allosomes with any differential heredity that they may possess, does not influence the sexual state, but the same secondary sexual condition remains in the cells with each kind of allosomes, all four giving rise to microspores with secondary male characters and these in turn all develop male gametophytes which finally produce male gametes with primary male states. Now if these allosomes were secondary sex producers in the diploid sporophytes, allosome *B*, of the heterozygous, staminate Japanese hop plant, being dominant over allosome *A*, might be expected to continue maleness when alone, but what is it then that continues maleness in the microspore and male gametophyte when allosome *A* is alone, the assumed, activating cause of maleness, the dominant allosome *B* being absent? In the carpellate plant the homozygous allosomes *AA* are assumed to determine the femaleness, and after the reduction division the female state is continued in all the spores produced and their following gametophytes. Why do the cells with allosome *A* produce female gametophytes in the one case and male gametophytes in the other if they are the cause of sex determination? In the diploid carpellate plants the homozygous allosomes *AA* are assumed to determine the femaleness and after the reduction division the female state is continued in all the subsequent haploid cells. The microspores, which have the single allosome *A*, produce male gametophytes exactly the same as those with allosome *B*. The allosome *A* is absolutely impotent and does not influence either the primary or secondary sexual states which have been established before the reduction division. If the conditions are the reverse in some higher plants,

the carpellate individual having the heteromorphic pair of allosomes, the results will still be the same except that in this case the allosome *A* would have no ability to change the sex to maleness in the gametophyte coming from the megaspore. It must be recalled again that in such plants with allosomes like the Japanese hop, the carpellate plant homozygous for *A* can easily be reversed to the male condition and the staminate plant with the heterozygous *AB* can easily be reversed to the female condition.

In those higher, homosporous, vascular plants in which unisexual gametophytes are developed, the determination presumably takes place in the spores. Now these haploid gametophytes, as stated above, can also be made to reverse their sex, the male to the female and the female to the male, so it is self-evident that both haploid complements of chromosomes contain the potentialities for both sexes, and determination could not have been brought about in the first place because of any sex-determining factorial difference, nor could it have been reversed later because of a factorial difference. It is evident that the process of reversal must be ultimately the same and dependent on the same conditions as the original sex determination.

In the higher animals with a simple diploid life cycle, the conditions are the same as in the higher plants. The secondary sexual state present in the individual is passed on to the cells after reduction, whether only three or four are produced or many, as is the case in a few species, and ends in the same primary sexual state. The segregation of chromosomes and hereditary factors, even when allosomes are present, has no influence on the secondary and primary sexual states of the generation of haploid cells. If the male has the heteromorphic allosomes, all the four cells coming from the spermatocyte through reduction, both those with allosome *A* and those with allosome B, develop the primary male state, the allosomes showing a complate impotence to effect either the secondary or primary sexual states or the morphology that goes with them. In the female all the cells which develop as eggs have allosome *A* and continue the female condition not because of the presence of this chromosome but because the sexual state handed over from the diploid female individual has in the meantime not been changed. If the female individual has the heteromorphic allosomes, some of the reduction cells will

have the allosome *A* and some will have *B*, but all that develop will continue the female state handed over from the diploid female individual, the allosomes are as impotent to influence or change the female condition as they are in changing the male state.

It is positively known from the work of Blakeslee, Belling, and others that a haploid complement of chromosomes works in practically the same way as a diploid set. In the haploid sporophytes of *Datura* the sporophytic characters appear practically normal, having the usual *Datura* characters and developing the usual male and female characters in the flowers. Furthermore, we know that the triploid condition does not change the character essentially. The cause of endosperm development from a triple-fusion cell is not at all due to the triple complement of chromosomes but must be due to the differentiation and functional conditions of the cells involved. The triploid condition may result in a sporophyte as well as the diploid or haploid condition.

So there is no opportunity to attempt to explain away by ingenious, imaginary hypotheses and fairy tales the known impotency of the allosomes to produce sexual changes and determinations in the gametophytes by the plea that the allosomes, although impotent in the haploid condition, are powerfully potent in the diploid condition. As shown in the discussion above, they are certainly impotent in the diploid condition when it comes to a contest with external factors.

It seems that in nearly all cases the reduction division cells remain in the secondary sexual condition which was developed in the tissue from which the reduction cells arise or else, as in some lower forms, they are in a neutral condition, as in *Oedogonium* and other genera. So far as I am aware there is only one case known in the whole realm of living things where differential allosomes are associated with definite sexual states in the haploid condition, namely in *Sphaerocarpus* as worked out for the most part by Allen. And here again we have the same puzzle, only reversed, as in the higher plants and animals. If we say the allosomes of *Sphaerocarpus* are sex-producing, to say nothing of sex-determination, their potency vanishes so soon as we get them in a diploid condition, for a completely non-sexual sporophyte is the result of their association in fertilization. The

generally assumed dominance of one of the heteromorphic allosomes on which the entire homozygous heterozygous hypothesis is established, is singularly lacking. Yet in recent times investigators who have been dealing with the supposed allosomes in higher plants, where they are absolutely impotent in producing any sexual changes whatever in the gametophytes, have not hesitated to consider their discoveries as being of the same nature as those in *Sphaerocarpus*. How are we to explain the differential association of sex and allosomes in *Sphaerocarpus?* I answer, in the same way as we do in other cases. The allosomes probably contain differential functional factors which have enough potency to set up a proper physiological condition in the given environment, which throws the sex one way or the other. To get a different association of the sexual state and the allosome it will be necessary to find a proper environment in which to develop the individual, and then, as in the case of a reversed hen or a reversed Japanese hop plant, the sexual state of the individual and the allosome condition will be just the opposite from what they are in the normal.

Sexuality manifests itself in several progressive or orthogenetic stages, in organisms in general, which may be summarized as follows:

First, in the lowest condition, it arises from time to time in the cell lineage of the lowest sexual organisms as a functional plus (+) or minus (—) condition of morphologically quite similar gametes, giving them the property of attraction and fusion. In this stage it is purely a physiological and chemical manifestation.

In the second stage of evolution, sexuality shows itself in the early developmental stage of the gametes, giving them a primary sexual dimorphism of the usual heterogamous type, common to all the higher plants and animals, in addition to the primary functional property of attraction and fusion. This evolution of heterogamy is represented by a number of progressive stages. In the lowest heterogamous gametes, the only dimorphism exhibited is one of a difference in size. The highest in the series show not only a very great difference in size but also a decided difference in character and function, represented by the large stationary egg and the small motile sperm.

The third stage is represented by the appearance of secondary sexual states in cells and tissues outside of those destined to

become gametes and giving rise to secondary sexual characters, in the lowest condition involving only the cells immediately contiguous to the gamete producing cells or cells in the immediate vicinity of the gamete producing cells. In the higher types considerable areas of the body are differentiated as male or female tissues. This type of sexual expression includes all hermaphroditic animals, all hermaphroditic diploid plants with a simple life cycle, all hermaphroditic haploid plants with a simple sexual cycle, and all the plants with the lower type of alternation of generations as well as all those with the higher antithetic alternation of generations which have hermaphroditic gametophytes.

The fourth stage of advancement in sexual evolution is represented by all those organisms on the one hand with a simple life cycle with diploid or haploid individuals, in which the sex is determined in the spore or in the fertilized egg and consequently in which secondary sexual dimorphism may appear in the entire individual, the individual being either male or female; and is also represented on the other hand by all organisms with haploid unisexual gametophytes and homosporous sporophytes. Examples of this stage of sexual evolution are unisexual fucoids, all the unisexual animals up to man, and all the bryophytes and homosporous pteridophytes with unisexual gametophytes.

The fifth stage is represented by those organisms with a typical antithetic alternation of generations in which the time of secondary sex determination is thrown back into the vegetative phase of the sporophyte, the sporophytic individual being bisporangiate and the gametophytes unisexual. The bisporangiateness of the sporophyte also is evolved in a series of stages in which the maleness and femaleness of the sexually differentiated regions is determined in earlier and earlier stages of the ontogeny. In the lowest stage maleness and femaleness are determined side by side in neighboring sporangia; in the more extreme evolutionary stages entire branches of a monecious individual are determined as male or female. In this category come the vast majority of species of heterosporous vascular plants.

The sixth and last general stage of sexual evolution is represented by the heterosporous plants with unisexual gametophytes and diecious sporophytes. In this condition there are four distinct individuals in the life cycle which manifest secondary

sexual states, two dimorphic gametes with primary sexual states, and two very dimorphic nonsexual spores with secondary sexual states. The sex is determined in the zygote or fertilized egg and this determination remains throughout the alternation life cycle until the following zygote, at which stage it is determined anew. Sex reversal apparently may readily take place anywhere in the body of the sporophyte or in its sporocytes, but probably is practically impossible in the gametophyte unless it were possible to develop it independently outside of its normal environment, the sporangium.

But these last two types of sexual organisms each have a still more complicated phase in their angiospermous members, in that in addition to the egg, the female gametophyte develops two or more special cells, with primary sexual states, which unite with each other and with the second sperm about the time of the union of the egg and sperm; and from this triple or multiple cell fusion a special nourishing generation arises, the so-called xeniophyte or endosperm. Now each stage of sexual evolution shows all the characteristics and usually also the degree and extent of sexualization of all the stages antecedent to it, so that at each stage there is a progressive addition to what was evolved previously.

Why should we think that the facts of sexual duality and determination need a factorial explanation when no such assumption has ever explained the most patent phenomena in relation to sex? Why do theorists not concern themselves with a factorial explanation for the cause and determination of the far greater dimorphism exhibited between sporophyte and gametophyte? Why is no factorial explanation forth-coming for the cause of the dimorphic expression of the sterile and fertile shoots of such plants as *Equisetum arvense?* We do not find any factorial explanations of the fact that in certain ferns highly dimorphic foliage leaves and sporophylls develop. We do not hear discussions concerning the probable factorial cause of root and shoot development in an ordinary plant. We do not read highly entertaining dissertations on the hereditary cause of the fruitfulness in a tree one year and of its almost complete sterility or unfruitfulness another. Then why should we attempt to find such an explanation for the dual expression of sexuality? But some one will say these cases do not involve individuals but only parts of

individuals. Well, so are the lower plants and animals practically all hermaphrodites and the higher sporophytes very largely bisporangiate individuals. As stated, at the beginning of the evolutionary series, sexuality manifests itself purely as a functional state of the cell which may come and go, be one sexual state in a cell lineage at one time and another state at another time; and so it has remained up to the highest organisms. In the evolutionary progression the cell has acquired a greater and greater aggregate of potentialities or hereditary factors, if you please, which can be activated, influenced, or inhibited by the presence of the one sexual state or the other, but the fundamental reality of sexuality has remained the same, a reversible physiological condition of the protoplasm. In the evolution of chromosomes the fact of sexuality has made possible the development of allosome sets of chromosomes which commonly show a definite association with one sex or the other in many unisexual and monosporangiate species, but unisexuality is just as prevalent in organisms where no such association of allosomes is indicated as in the unisexual gametophytes of all the higher plants. Allosomes are merely indicators of sex in certain groups of organisms. They follow the sex rather than determine it. They do not appear to be directly responsible in any case—although it is possible that they might be indirectly concerned—for any specific sex determination; nor are they responsible for the fixity of the sexual states when present, since it is absolutely established that sex reversal takes place in their presence. There are allosome-linked hereditary factors as there are autosome-linked factors and there are sex-limited or sex-influenced factors in both allosomes and autosomes as well as factors which are not sex-limited. Sex-limitation may be accomplished in single dose but not in double dose, or even a double dosage may be inhibited by a given sexual state and these conditions apply to the hereditary potentialities of both allosomes and autosomes. But, properly speaking, there are no sex chromosomes and especially is it true that there are no "sex-linked" factors. Such terminology leads only to confusion of ideas. Sexuality is a potentiality of all organisms or cells except the very lowest. This potentiality probably has its basis in some structural condition of the protoplasm. This potentiality is responsible for the development of sexual states, which may be male, female or neutral. Any cell or any in-

dividual not differentiated beyond the possibility of regeneration or rejuvenation has the potentiality to pass into any of these states. Depending on the sexual state present, various specific substances are produced in the cell and these as well as the state itself influence hereditary expression; that is, they activate, inhibit, or modify hereditary expression, or the hereditary factors. The cause of the establishment of any sexual state in any degree of intensity or stability is to be sought in the physiological activity of the cell.

Finally then, the persistency of sexual states is due to differentiation processes which proceed in the same manner when sexual differentiations take place, whether morphological or physiological, as when nonsexual differentiations are accomplished. Or as Stout has stated the matter: "The morphological differentiations of sex are fundamentally an extension of the phenomena of somatic differentiation."

COLUMBUS, OHIO.

Additions to the genus Lycianthes Dunal

H. H. Rusby

The reinstatement and extension of the genus *Lycianthes* by Dr. George Bitter (Abh. Nat. Ver. Brem. **24**: 292–520. 1919.) is an important contribution to the literature of the family *Solanaceae*, especially in view of the critical and accurate manner in which the work has been performed. Every botanist who has done much work in this family must have been dissatisfied, at times, with the best disposition that he could make of his species. The difficulty is inherent in the family itself, which seems incapable of any perfect natural arrangement based on structural characters. *Atropa* and *Scopolia*, related naturally, are separated by the circumscissile pod of the one and the berry of the other; yet we cannot overlook the fact that *Scopolia* and *Hyoscyamus* possess equally natural affinities. *Solanum*, at one end of the family, has species with the saccate bilabiate corolla which characterizes genera at the other end. *Capsicum* and *Bassovia* appear perfectly dissociated as natural groups, yet their structural distinctions are most slender, and at times fail. The genus *Lycianthes* itself is not wholly satisfactory as a natural group. Its basic characteristic, the possession of 10 calyx-teeth, is not absolutely constant, and its wide and diverse distribution is evidence against its naturalness. Nevertheless, *Lycianthes* affords us the means for eliminating many glaring inconsistencies that have offended all special students of the family. Made up, as it is by Bitter, of 5 species from *Capsicum*, 7 that have been erroneously referred to *Bassovia*, the whole of the genus *Brachistus*, 2 species from *Chamaesaracha*, 9 from *Cyphomandra*, 10 from *Lycium*, 11 from *Parascopolia*, and no less than 250 from *Solanum*, with 134 new species, it becomes a very large genus. Yet, considering that more than a score of undescribed species have already accumulated in the herbarium of the New York Botanical Garden, and that current collections continue to add rapidly to the number, it is clear that the extent of the genus is not yet realized, and that it may vie with *Solanum* itself.

Another result that has come from Dr. Bitter's work is that of establishing the validity of small differences as possessing specific rank. With these plants, as with so many genera,

before becoming well understood, we have not known whether small differences, sometimes minute ones, under consideration, were to be regarded as specific characteristics or merely individual variations. A study of such of Dr. Bitter's recognized species as I know makes it pretty certain that, as a general rule, we must recognize such distinctions as specific, in this genus.

A few species, now classed in other genera, which apparently have not been seen by Dr. Bitter, are here transferred, and a number of new ones, from Bolivia and Colombia, are proposed.

Many others, from Guiana, Venezuela, Colombia, Ecuador and Central America, remain in our herbarium for future treatment by those concerned with the floras of those countries. The type-specimens of all species here enumerated and described are deposited in the Herbarium of the New York Botanical Garden.

Lycianthes hispida n. comb. (*Brachistus hispidus* Rusby, Bull. Torrey Club, **26:** 198. 1899.)

Lycianthes ferruginea n. comb. (*Bassovia ferruginea* Rusby, Descriptions of Three Hundred New Species of South Am. Plants, 117. 1920.)

Lycianthes Fendleri n. comb. (*Bassovia Fendleri* Rusby, Bull. Torrey Club **26:** 197. 1899.)

Lycianthes coccinea n. comb. (*Brachistus coccineus* Rusby, Bull. N. Y. Bot. Gard. **8:** 117. 1912.)

Lycianthes leptocaulis n. comb. (*Brachistus leptocaulis* Rusby, Bull. Torrey Club, **26:** 199. 1899.)

Lycianthes recticarpa n. sp. Young portions puberulent. Stems slender, much-branched, the short branchlets widely spreading, lightly angled. Leaves extremely irregular in size, on petioles 1 to 1.5 cm. long, from 2.5 by 1 cm. to 8 by 4 cm., ovate, with broadly rounded or subtruncate base and acuminate acute summit, thin, deep-green, the slender venation lightly prominent beneath, the secondaries 5 or 6 on each side, strongly ascending and lightly curved, crooked, connected by slender, crooked tertiaries. Pedicels mostly 2 together, filiform, 1 cm. long in flower. Flowering calyx-tube sub-hemispherical, 3 mm. long, 5 mm. broad, the 10 teeth equal, 2.5 mm. long, linear, thick, obtuse, erect. Corolla purple, thick, 1.5 cm. long. Four stamens half as long as the corolla (unopened), the fifth 2 mm. longer. Filaments very short. Anthers 4 mm. long, oblong, the base cordate. Style nearly as long as the corolla.

Collected by Herbert H. Smith at Quebrado del Cabo, Santa Marta, 100 feet, Aug. 26 (1876).

"A vine, to 20 ft., in swampy places below 500 feet."

Lycianthes reflexa n. sp. Densely yellowish-pubescent, with simple acute hairs, those of the stem, etc., divaricate or slightly retrorse. Branches elongate, slender, erect or strongly ascending, straight or more or less flexuous, terete, striate or lightly angled above. Leaves sessile, but with a short narrow petiole-like base, to 13 cm. long, and 3 cm. broad, lanceolate with long and narrowly acuminate summit, and short-acuminate base, entire, thin, yellowish-green, especially beneath, the midrib stout, prominent beneath, the secondaries, 8 or 10 on each side, very slender, strongly falcate-ascending, the remaining venation obscure. Smaller leaves mostly 1.5 to 2.5 cm. by 8 to 15 mm., oval, not acuminate. Pedicels mostly solitary, sometimes 2 together, in flower, slenderly filiform and 3 or 4 cm. long, in fruit thickening but not much elongating, strongly reflexed. Calyx pubescent with divaricate hairs, the tube turbinate-campanulate, membranaceous, with 10 green nerves, 3 mm. long, 5 mm. broad, the 10 teeth subequal, slenderly setaceous, erect, spreading or recurved, 2 mm. long in flower, becoming 3 mm. in fruit. Corolla apparently purple, 6 mm. long, divided nearly to the base. Stamens two-thirds the length of the corolla, equal. Filaments nearly as long as the anthers, which are coriaceous, brown, 3 mm. long, oval, obtuse, the pores small. Style stout, longer than the stamens.

Collected by M. Bang in Bolivia, without data (*no. 2617* the type). Distributed and published as "*Brachistus lasiophyllus* (Dunal)" but differing from that species, as described by Bitter, in several important particulars. Also collected by the author in Yungas, 6000 ft. (Parke, Davis & Co., *no. 2617*).

Lycianthes tomentella n. sp. Stellate-tomentose. Stems stout but weak, terete, finely nerved or lightly angled above, sometimes reddish, the branchlets short, widely spreading, leafy at the ends. Petioles to 2 cm. long, broad but weak. Blades very unequal, from 4 by 1.5 cm. to 12 by 6 cm., oval with very slightly produced base and obtuse summit, thickish but weak, deep-green, often with reddish venation, shortly stellate-hairy and roughish, the venation coarse, prominent beneath, tomentose, the secondaries 6 or 8 on each side, widely spreading, then strongly up-curved, connected by few crooked tertiaries, the remaining venation obscure. Pedicels two to several, in flower 1 or 1.5 cm. long, thick but weak, slightly thickened upward, elongating and thickening somewhat in fruit, tomentose, like the calyx. Calyx-tube campanulate, 4 mm. long and broad, 10-ribbed, the 10 teeth irregularly unequal, to 3 mm. long in flower,

twice as long in fruit, linear, thick, obtuse. Corolla purple, pubescent, nearly 2 cm. long, divided three-fourths of the way or more. One stamen nearly twice as long as the others. Filaments very short, the smaller anthers 4 mm. long, coriaceous, lanceolate, lightly curved, obtuse, the pores whitish, on a narrow, slightly projecting summit. Style slightly exceeding the long stamen, rather stout, the stigma truncate. Only young fruit seen.

Collected by M. Bang (*no. 630*) in Yungas, Bolivia. Distributed and published as "*Solanum Sprucei* Van Heurck & Müller," and afterwards regarded as a species of *Brachistus*.

Lycianthes pyrifolia n. sp. (Fruiting specimen.) Branches elongated, stout, angled, flexuous, reddish-brown, more or less bristly with deciduous divaricate hairs, some, at least, of which are glandular. After the fall of the hairs, the stem is finely muricate or papillose. Petioles to 2 cm. long, stout, narrowly grooved above, like the midrib. Blades to 1.5 dm. long, 7 cm. broad, ovate, with broadly rounded or sub-truncate base and abruptly acuminate and acute summit, thin, dark-green, glabrous above, with the venation slightly prominent, the midrib sometimes minutely hairy, the principal veins of the lower surface more so, the secondaries, 6 or 8 on each side, strongly falcate-ascending, connected by few tertiaries. Pedicels 2 or 3 together, 1.5 cm. long, in fruit, slender, terete, thickened upward, pilose with whitish divaricate hairs. Fruiting calyx-tube slightly recurved, about 1 cm. broad, coriaceous, the 10 teeth 3 mm. long, linear, thick, obtuse. Mature fruit globose, glabrous, in the dried state 1.5 cm. broad, but evidently much reduced in drying, much wrinkled.

Collected by Otto Buchtien (*no. 2816*), at Espirito Santo, near Cochabamba, Bolivia, 750 meters, June 1909.

Species very near *L. hispida* Rusby.

Lycianthes polycarpa n. sp. (Fruiting specimens.) Finely puberulent throughout with extremely short stellate hairs. Branches thickish but weak, very flexuous, terete, reddish, finely many-nerved. Petioles 1 cm. long, grooved above, like the lower part of the midrib. Blades (only the upper seen) to nearly 1 dm. long, 5 cm. wide, ovate with rounded, very slightly produced base and abruptly short-pointed very acute summit. Pedicels mostly 3 together, the fascicles crowded toward the ends of the branches, 7 to 10 mm. long, slender, thickened upward, slightly angled. Calyx-tube rotate, about 8 to 9 mm. broad, 10-ribbed, the narrow margin and 10 teeth mostly sharply recurved in fruit, the teeth about 2 mm. long, thick, linear, obtuse. Berry globoidal, 1 cm. broad and a little longer.

Collected by the author along the Beni River, Bolivia, July 1886 (Parke, Davis & Co., *no. 798* the type). Also at Guanai, 2000 ft., May 1886 (*no. 784*).

Species very near Buchtien's *2816*.

Lycianthes Herbert-Smithii n. sp. Stellate-tomentellate. Stems slender, terete, finely nerved, strongly flexuous. Petioles to 15 mm. long, rather stout, flattened above. Blades of the smaller leaves 2 to 4 cm. by 1 to 2 cm.; of the larger 5 to 8 cm. by 3 to 4 cm., regularly ovate, with rounded base and abruptly short-acuminate acute summit, pale-green, very finely tomentellate above, more strongly so beneath, the slender venation prominent beneath, the secondaries 6 or 8 on each side, somewhat crooked, strongly falcate-ascending, connected by few crooked tertiaries. Peduncles solitary or two together, in flower 2 to 3 cm. long, slender, erect, the hairs longer than on the stems, those of the young fruit somewhat longer and stouter. Calyx-tube crateriform or short-cupulate, in flower 4 mm. long by 5 mm. broad, in young fruit 4 mm. long by 13 mm. broad, the teeth unequal, the alternate ones nearly a half longer than the others, 7 mm. long in flower, moderately elongating in fruit, linear, obtuse, tomentose like the tube. Corolla rotate, 2 cm. broad, bearing 5 lanceolate ribs, shortly 5-toothed. One stamen longer. Filaments shorter than the anthers, the latter lance-oblong, obtuse, 4 mm. long, the pores looking inward and a little upward. Style filiform, much exceeding the stamens, the stigma small. Young fruit tomentellate.

Collected by Herbert H. Smith (*no. 1179*), at Sierra del Libano, 6000 ft., Jan. 26, 1899, heretofore referred with doubt to *Brachistus Sanctae Caroli* Winkler, but sufficiently distinct therefrom.

"A diffuse vine-like shrub, rare in damp clearings, 4000 to 6000 ft., the flowers white."

Several additional species from Bolivia will shortly be published in my report on new species and genera of the Mulford Collection, in the Bulletin of the New York Botanical Garden.

College of Pharmacy,
Columbia University

Bertoloni's Guatemalan Asteraceae

S. F. Blake

Antonio Bertoloni (1775–1869), for many years professor of botany at the University of Bologna, and author of one of the two principal floras of Italy, described many new species of plants from North America in the '40's and '50's of the last century. Nearly all those from the United States were based on specimens collected in Alabama by Dr. Hezekiah Gates and given to Bertoloni in 1834 by Prince Charles Bonaparte, the well-known ornithologist. Many of these have since been reduced to synonymy by Dr. Asa Gray and others. Bertoloni's much more important work[1] on the flora of Guatemala has had comparatively little attention from botanists. This "Florula," enumerating 79 species of which 60 were described as new, was based on a collection of plants and seeds brought from Guatemala in 1836 by Joachim Velasquez (also spelled Vellasquez by Bertoloni), who served as Mexican ambassador at the papal court. The new names here published are of course listed in the Index Kewensis and (with some omissions) in Hemsley's Botany of the Biologia Centrali-Americana, but little attempt has been made to identify them. The examination of Bertoloni's types by a botanist familiar with the flora of Central America would be sure to lead to interesting results.

Bertoloni's herbarium and library are still very carefully preserved in their original rooms at the Bertoloni home at Zola Pedrosa, some ten miles outside Bologna, by Dr. Cav. Antonio Bertoloni, the grandson of Antonio Bertoloni the elder. Dr. Bertoloni, a well-preserved old gentleman of 82, is himself a botanist, who has recently (1917) commemorated the hundredth anniversary of the calling of his grandfather to the professorship of botany at the University of Bologna by the publication of a list of unrecorded Italian lichens in the Bertoloni Herbarium. On a hot morning in July, 1925, having made the trip from Bologna by automobile, I was courteously received by Dr. Bertoloni and

[1] "Florula Guatimalensis," Nov. Comm. Acad. Sci. Bonon. **4**: 403–443. *pl. 36–47*. 1840. The references in the Index Kewensis to this paper are to the separate ("Florul. Guatim."), with a pagination uniformly 400 less than the original. I have not seen the separate.

permitted to examine the types of all the new Guatemalan Asteraceae described in the "Florula Guatimalensis" and to obtain fragments of several for the United States National Herbarium.

The specimens in the Bertoloni Herbarium, still in perfect condition owing to the fact that they were well poisoned many years ago, lie loose with their labels in paper folders. The species of each genus are grouped in folders, and several or many genera are bound up between cardboards in packets of various sizes which stand on the shelves of the cases, and bear on the side a list of the genera contained. The exotic herbarium, the only one I had occasion to consult, is arranged by the Linnaean classes, as is doubtless the still larger herbarium, filling another room, on which the "Flora Italica" was based.

Bertoloni described ten new Asteraceae (reducible to nine) from Guatemala, all from Volcan de Agua ("Vulcano d'acqua" of Bertoloni), besides listing two others. Eight represent species which were actually undescribed at that time, but the names of two of these are preoccupied and hence unavailable. The following list of identifications is arranged in the current order of classification.

STEVIA POLYCEPHALA Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 432. 1840.

Stevia arachnoidea Robinson, Proc. Amer. Acad. **35**: 326. 1900.

Bertoloni's *Stevia polycephala* is clearly the same as *S. arachnoidea* Robinson, described from the same locality, Volcan de Agua. Robinson's type (*J. D. Smith 2327*) has not been examined by the writer, but comparison of fragments from Bertoloni's type has been made with *Maxon & Hay 3677* and *Pittier 10* (of 1905), both from Volcan de Agua, as well as with *E. W. Nelson 3649*, from near the Hacienda of Chaucol, alt. 3080 m., Guatemala. Dr. Robinson informs me that he had previously recognized the identity of the two species, although apparently no published record of the fact has been made. Bertoloni's name was omitted from the Botany of the Biologia Centrali-Americana.

GNAPHALIUM SALICIFOLIUM (Bertol.) Sch. Bip. Bot. Zeit. **3**: 172. 1845.

Helichrysum salicifolium Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 433. 1840.

Gnaphalium rhodanthum Sch. Bip. in Seemann, Bot. Voy. Herald 310. 1856.

Bertoloni's name, apparently not used again since it was transferred without discussion by Schultz Bipontinus, is the earliest given to this species. Specimens collected by W. A. Kellerman (*no. 4951*) and H. Pittier (*no. 46* of 1905) on Volcan de Agua, the type locality of *Helichrysum salicifolium*, are in the National Herbarium, as well as a fragment of Bertoloni's type. Both *Helichrysum salicifolium* and *Gnaphalium salicifolium* are omitted from Hemsley's Botany of the Biologia Centrali-Americana.

Tithonia longeradiata (Bertol.) Blake.

Helianthus longeradiatus Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 436. 1840.

Tithonia scaberrima Benth. in Oerst. Naturh. For. Kjöbenhavn Vid. Med. **1852**: 91. 1852; Blake, Contr. U. S. Nat. Herb. **20**: 432. 1921 (synonymy).

SIMSIA SERICEA (Hemsl.) Blake, Proc. Amer. Acad. **49**: 393. 1913.

Verbesina argentea Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 435. 1840. Not *V. argentea* Gaud. in Freyc. Voy. Bot. 463. 1826.

Encelia (? *Simsia*) *sericea* Hemsl. Biol. Centr. Amer. Bot. **2**: 185. 1881.

Bertoloni's name, *Verbesina argentea*, the first that was given to this species, is not available because of its previous use by Gaudichaud for a still doubtful plant from the Marianne Islands.

BIDENS CANESCENS Bertol. Nov. Comm. Act. Sci. Bonon. **4**: 431. 1840.

Maxon & Hay 3690, in the National Herbarium from Volcan de Agua, the type locality, has been identified as this species by Dr. E. E. Sherff and agrees with my notes on Bertoloni's type.

BIDENS SQUARROSA H.B.K. Nov. Gen. & Sp. **4**: 238. 1820.

Coreopsis trifoliata Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 436. 1840.

From Bertoloni's description and my notes and sketches of

the type, a mere scrap about 4 inches long, it is evident that *Coreopsis trifoliata* is merely one of the forms of the variable *Bidens squarrosa* H.B.K.[2]

SENECIO ACUTANGULUS (Bertol). Hemsl. Biol. Centr. Amer. Bot. **2**: 235. 1881.

Cineraria acutangula Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 435. 1840.

This species has apparently not been re-collected. A single head from the type and a sketch of a leaf are in the National Herbarium.

SENECIO GODMANII Hemsl. Biol. Centr. Amer. Bot. **2**: 240. 1881.

Cacalia cuspidata Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 432. 1840. Not *S. cuspidatus* DC. 1836.

This species is represented in the National Herbarium by several specimens collected on Volcan de Agua, the type locality of Bertoloni's plant—*Kellerman 4749, Maxon & Hay 3672, 3684, 3708*. Hemsley's type of *S. Godmanii* came from near Santa Maria, Volcan de Agua (*Salvin & Godman 327*). A single head from Bertoloni's type is in the National Herbarium. Bertoloni's name is omitted from the Biologia Centrali-Americana.

Lycoseris crocata (Bertol.) Blake.

Carduus cernuus Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 431. 1840. Not *Carduus cernuus* (L.) Steud. Nomencl. ed. 1. 151. 1821.

Aster crocatus Bertol. Nov. Comm. Acad. Sci. Bonon. **4**: 434. 1840.

Lycoseris squarrosa Benth. Bot. Sulph. 121. 1844.

Bertoloni described the sexes of this shrub under different names, his *Carduus cernuus* being the pistillate plant, his *Aster crocatus* the staminate. Both are specifically identical with the Central American plant hitherto known as *Lycoseris squarrosa* Benth., which was originally described from "Nicoya, Gulf of Fonseca, Panama." Both of Bertoloni's names are omitted by Hemsley.

[2] See the discussion of this species by E. E. Sherff, Bot. Gaz. **64**: 35–38. *pl. 9, 10.* 1917.

INDEX TO AMERICAN BOTANICAL LITERATURE
1914–1926

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index should be addressed to the Bibliographer of the Torrey Club, Mrs. Helen Smith Hill, Brooklyn Botanic Garden, Brooklyn, N. Y.

Allen, C. E. The direct results of Mendelian segregation. Science II. **62**: 524. 4 D 1925.

Anderson, P. J. Comparative susceptibility of onion varieties of species of *Allium* to *Urocystis cepulae*. Jour. Agr. Res. **31**: 275–286. "1 Au" S 1925.

Andrews, F. M. An abnormal archegonium of *Funaria hygrometrica*. Bot. Gaz. **80**: 337. *f. 1.* 30 N 1925.

Antevs, E. The big tree as a climatic measure. Carnegie Inst. Wash. Publ. 352: 117–153. *f. 1–7+pl. 1.* Jl 1925.

Bailey, D. L. Sunflower rust. Minnesota Agr. Exp. Sta. Tech. Bull. 16: 1–31. *pl. 1–3.* Au 1923.

Bailey, I. W. Notes on the "spruce budworm" biocoenose. II. Structural abnormalities in *Abies balsamea*. Bot. Gaz. **80**: 300–310. *f. 1–3+pl. 13–15.* 30 N 1925.

Barker, H. D. A study of wilt resistance in flax. Minnesota Agr. Exp. Sta. Tech. Bull. 20: 1–42. *pl. 1–14.* N 1923.

Bergman, H. F. The respiratory activity of various parts of the cranberry plant in relation to flooding injury. Am. Jour. Bot. **12**: 641–659. *f. 1–8.* 18 D 1925.

Berry, E. W. A banana in the teriary of Colombia. Am. Jour. Sci. V. **10**: 530–537. *f. 1, 2.* D 1925.
Musa enseteformis, described as new species.

Blake, S. F. On the status of the genus *Chaenocephalus*, with a review of the section Lipactinia of *Verbesina*. Am. Jour. Bot. **12**: 625–640. 18 D 1925.
1 species, *Verbesina Cumingii*, and several names, described as new.

Bradshaw, R. V. Pacific coast species of *Lathyrus*. Bot. Gaz. **80**: 233–261. *f. 1–29.* 30 N 1925.
1 species, *L. Tracyi*, and several combinations, described as new.

Britton, E. G. Our Christmas greens. Am. For. & For. Life **31**: 725–727. *illust.* D 1925.

Brooks, M. M. A note on the rate of growth of *Valonia macrophysa*. Am. Jour. Bot. **12**: 617–618. *f. 1.* 18 D 1925.

Brownell, L. W. Nature's rosettes of winter green. Nat. Mag. **7**: 13–16. *illust.* Ja 1926.

Burns, G. P. Studies in tolerance of New England forest trees. —I. Development of white pine seedlings in nursery beds. Vermont Agr. Exp. Sta. Bull. 178: 127–143. *f. 1, 2 + pl. 1–4.* Mr 1914; —II. Relation of shade to evaporation and transpiration in nursery beds. Vermont Agr. Exp. Sta. Bull. 181: 235–262. *f. 1, 2 + pl. 1–7.* My 1914.

Burns, G. P. Studies in tolerance of New England forest trees. —IV. Minimum light requirement referred to a definite standard. Vermont Agr. Exp. Sta. Bull. 235: 1–31. *f. 1, 2 + pl. 1–4.* Jl 1923.

Castle, H. A revision of the species of *Radula* of the United States and Canada. Bull. Torrey Club **52**: 409–445. *f. 1–11.* "N" 18 D 1925.
R. Langloisii, described as new species.

Chaney, R. W. A comparative study of the Bridge Creek flora and the modern redwood forest. Carnegie Inst. Wash. Publ. 349: 1–22. *pl. 1–7.* Au 1925.

Chaney, R. W. The Mascall flora—its distribution and climatic relation. Carnegie Inst. Wash. Publ. 349: 23–48. *f. 1 + pl. 1.* Au 1925.

Chaney, R. W. Notes on two fossil hackberries from the Tertiary of the western United States. Carnegie Inst. Wash. Publ. 349: 49–56. *pl. 1.* Au 1925.
Celtis obliquifolia and C. Hatcheri described as new species.

Chaney, R. W. A record of the presence of *Umbellularia* in the Tertiary of the western United States. Carnegie Inst. Wash. Publ. 349: 57–62. *pl. 1.* Au 1925.
U. oregonensis described as new species.

Cook, M. T. El mosaico del tabaco. Rev. Agr. Puerto Rico **15**: 246. N 1925.

Cook, M. T. "El salcocho" en los semilleros de tabaco. Rev. Agr. Puerto Rico **15**: 187–188. O 1925.

Cook, M. T. Histology and cytology of sugar cane mosaic. Jour. Dept. Agr. Porto Rico **9**: 5–27. Ja 1925.

Coons, G. H., & Klotz, L. J. The nitrogen constituents of celery plants in health and disease. Jour. Agr. Res. **31**: 287–300. "1 Au" S 1925.

Dana, B. F. The *Rhizoctonia* disease of potatoes. Washington Agr. Exp. Sta. Bull. 191: 1–78. *f. 1–13.* Au 1925.

Davidson, A. *Comandra nudiflora* n. sp. Bull. So. California Acad. Sci. **24**: 68. 15 N 1925.

Dodge, A. W. Some data on elm trunk canker. Tree Talk 7^2: 4–6. *illust.* 1926.

Dosdall, L. Factors influencing the pathogenicity of *Helminthosporium sativum.* Minnesota Agr. Exp. Sta. Tech. Bull. 17: 1–47. *f. 1–7 + pl. 1–6.* Jl 1923.

Estes, F. E. The shrubby Malvastrums of southern California. Bull. So. California Acad. Sci. **24**: 81–87. 15 N 1925.

4 varieties and 1 combination, described as new.

Fawcett, H. S. Bark diseases of citrus trees in California. California Agr. Exp. Sta. Bull. 395: 1–61. *f. 1–19.* O 1925.

Free, E. E. Physiological features of roots, with especial reference to the relation of roots to aeration of the soil. Carnegie Inst. Wash. Publ. 368: 1–168. *f. 1–21.* Au 1925.

Fuller, G. D. The vegetation of the Chicago region. An outline of some of the principal plant associations together with lists of their principal species. 1–27. Chicago, 1925.

Gaines, E. F. Resistance to covered smut in varieties and hybrids of oats. Jour. Am. Soc. Agron. **17**: 775–789. *f. 1.* D 1925.

Gleason, H. A. Studies on the flora of northern South America—VIII. Additional new species of Melastomataceae. Bull. Torrey Club **52:** 447–460. "N" 18 D 1925.

1 genus, *Killipia*, and species in *Miconia* (9), *Clidemia* (1), *Ossaea* (1), *Blakea* (3), *Topobea* (1), described as new.

Gramet, C. A. An historical approach to the study of photosynthesis and respiration in plants. Bull. High Points [N. Y. C.] **7:** 33–35. N 1925.

Haber, J. M. The anatomy and morphology of the flower of *Euphorbia*. Ann. Bot. **39:** 657–707. *f. 1–112.* O 1925.

Harland, S. C. Studies in cacao. Part I. The method of pollination. Ann. Applied Biol. **12:** 403–409. N 1925.

Harms, H. Ueber einige amerikanische Meliaceen. Notizbl. Bot. Gart. Berlin **9:** 426–434. O 1925.

Ruagea Jelskiana, Guarea microcalyx, and 3 species in *Trichilia*, described as new.

Hayes, H. K., Stakman, E. C., Griffee, F., & Christensen, J. J. Reaction of barley varieties to *Helminthosporium sativum*. I. Varietal resistance. II. Inheritance studies in a cross between Lion and Manchuria. Minnesota Agr. Exp. Sta. Tech. Bull. 21: 1–47. *f. 1–10.* Jl 1923.

Henderson, N. F. The carrot family in Ohio. Ohio Jour. Sci. **25:** 271–284. 23 N 1925.

Henry, A. W. Root-rots on wheat. Minnesota Agr. Exp. Sta. Tech. Bull. 22: 1–71. *f. 1, 2 + pl. 1–12.* Ap 1924.

Hibbard, P. L. A rapid method for demonstrating the effects of plants on a culture solution. Science II. **62:** 515–516. 4 D 1925.

Hitchcock, A. S. A botanical trip to Ecuador, Peru and Bolivia. Ann. Rep. Smithsonian Inst. **1924:** 335–351. *pl. 1–15.* 1925.

Hitchcock, A. S. The North American species of *Stipa*. Synopsis of the South American species of *Stipa*. Contr. U. S. Natl. Herb. **24:** i–xi, 215–289. *pl. 50–52.* 1925.

Holm, T. On the development of buds upon roots and leaves. Ann. Bot. **39**: 867–881. O 1925.

Holm, T. The vegetation of the alpine region of the Rocky Mountains in Colorado. Mem. Nat. Acad. Sci. **19**^{3}: 1–45. *pl. 1–7.* 1923.

Hopkins, E. F., & Wann, F. B. The effect of the H-ion concentration on the availability of iron for *Chlorella* sp. Jour. Gen. Physiol. **9**: 205–210. *f. 1.* 20 N 1925.

Hotson, J. W. Preliminary list of the Uredinales of Washington. Publ. Puget Sound Biol. Sta. **4**: 273–391. Au 1925.

Howard, G. E. Pigment studies with special reference to carotinoids in fruit. Ann. Missouri Bot. Gard. **12**: 145–212. *pl. 10–18.* Ap 1925.

Humphreys, W. J. Cunila, Jack Frost's favorite. Nat. Mag. **6**: 343–344. *illust.* D 1925.

Hunt, N. R., O'Donnell, F. G., & Marshall, R. P. Steam and chemical soil disinfection with special reference to potato wart. Jour. Agr. Res. **31**: 301–363. *f. 1–3* + *pl. 1*, 2. "15 Au" S 1925.

Huntington, E. Tree growth and climatic interpretations. Carnegie Inst. Wash. Publ. 352: 155–204. *f. 1–3.* Jl 1925.

Imai, Y. Inheritance of deformed leaves in *Pharbitis Nil.* Bot. Gaz. **80**: 276–287. *f. 1.* 30 N 1925.

Immer, F. R., & Christensen, J. J. The reaction of selfed lines and crosses of maize to *Ustilago Zeae.* Phytopathology **15**: 699–707. N 1925.

Irwin, M. Accumulation of brilliant cresyl blue in the sap of living cells of *Nitella* in the presence of NH_3. Jour. Gen. Physiol. **9**: 235–254. *f. 1–8.* 20 N 1925.

Johansen, F. General observations on the vegetation. Rep. Canad. Arctic Exp. **5**^{c}: 1–58. *pl. 1–14.* 7 O 1924.

Karlsen, A. Comparative studies on respiration—XXVIII. The effect of anaesthetics on the production of carbon dioxide by wheat under aërobic and anaërobic conditions. Am. Jour. Bot. **12**: 619–624. *f. 1–4.* 18 D 1925.

Killip, E. P. Twelve new species of *Valeriana* from the Andes of South America. Jour. Washington Acad. Sci. **15:** 450–456. 4 D 1925.

Klotz, L. J. A study of the early blight fungus, *Cercospora apii* Fres. Michigan Agr. Exp. Sta. Tech. Bull. 63: 1–42. *pl. 1–9.* N 1923.

Kunkel, L. O. Insect transmission and host range of aster yellows. Science II. **62:** 524. 4 D 1925.

Kvakan, P. Heritable characters of maize—XXIV. Twisted seedlings. Jour. Hered. **16:** 427–430. *f. 15–17.* 7 D 1925.

Lansdell, K. A. Weeds of South Africa—XVII. The "prostrate star-bur" (*Acanthospermum xanthoides* L.). Jour. Dept. Agr. So. Africa **11:** 428–435. *pl. 1–6.* N 1925.

Lynge, B. On some South American lichens of the genera *Parmelia, Candelaria, Theloschistes* and *Pyxine.* Nyt Mag. Naturw. **62:** 83–97. 1925.

McGivney, Sister V. de P. An unusual *Polygonatum.* Am. Midl. Nat. **9:** 663–664. *illust.* N 1925.

MacInnes, J., & Fogelman, R. Wheat scab in Minnesota. Minnesota Agr. Exp. Sta. Tech. Bull. 18: 1–32. *f. 1–4 + pl. 1–9.* Au 1923.

Madison, H. L. Trees of Ohio identified by their leaves. Cleveland Mus. Nat. Hist., Pocket Nat. Hist. Bot. Ser. 1: 1–24. *f. 1–116.* Ja 1922.

Malme, G. O. A. Die Xyridazeen der Insel Cuba. Arkiv Bot. **19**[19]: 1–6. 14 My 1925.

Several species described as new.

Mansfeld, R. Beiträge zur Kenntnis der südamerikanischen Ericaceen—I. Notizbl. Bot. Gart. Berlin **9:** 435–442. 31 O 1925.

Several species described as new.

Martin, G. W. Morphology of *Conidiobolus villosus.* Bot. Gaz. **80:** 311–318. *f. 1–3 + pl. 16.* 30 N 1925.

Martin, W. H. Plant diseases of New Jersey (Eighth instalment). Blotch—a serious disease of apples. New Jersey Agr. **7**[12]: 10–11. *illust.* D. 1925.

Mason, S. C. The inhibitive effect of direct sunlight on the growth of the date palm. Jour. Agr. Res. **31**: 455–468. *f. 1–3.* "1 S" O 1925.

Mason, S. C. The minimum temperature for growth of the date palm and the absence of a resting period. Jour. Agr. Res. **31**: 401–414. *f. 1–4.* "1 S" O 1925.

Mason, S. C. Partial thermostasy of the growth center of the date palm. Jour. Agr. Res. **31**: 415–453. *f. 1–6 + pl. 1–5.* "1 S" O 1925.

Melhus, I. E., & VanHaltern, F. *Sclerospora* on corn in America. Phytopathology **15**: 720–721. N 1925.

Merrill, E. D. Bibliography of Polynesian botany. Bernice Pauahi Bishop Mus. Bull. 13: 1–68. 1924.

Merrill, G. K. Lichens collected by the Canadian Arctic Expedition, 1913–1918. Rep. Canad. Arctic Exp. **4**[b]: 1–12. 16 Jl 1924.

Miles, L. E. A Pyrenomycetous leaf spot of bur clover. Phytopathology **15**: 677–690. *f. 1–4 + pl. 29, 30.* N 1925.
Pseudoplea medicaginis, described as new species.

Mitchell, G. E. Forests of chalcedony. Nat. Mag. **7**: 29–30. *illust.* Ja 1926.

Mottier, D. M. Polyembrony in certain Polypodiaceae and Osmundaceae. Bot. Gaz. **80**: 331–336. *f. 1–3.* 30 N 1925.

Muhleman, G. W. The pectinase of *Sclerotinia cinerea.* Introduction. Bot. Gaz. **80**: 325–330. 30 N 1925.

Munz, P. A. A new *Malvastrum* from California. Bull. So. California Acad. Sci. **24**: 88. 15 N 1925.
M. Jonesii.

Norton, G. F. The fringed gentian. Jour. N. Y. Bot. Gard. **26**: 261–262. N 1925.

Oberholser, H. C. The relations of vegetation to bird life in Texas. Am. Midl. Nat. **9**: 595–661. N 1925.

Olitsky, P. K. The transfer of tobacco and tomato mosaic disease by the *Pseudococcus citri*. Science II. **62**: 442. 13 N 1925.

Osterhout, W. J. V., & Dorcas, M. J. The penetration of CO_2 into living protoplasm. Jour. Gen. Physiol. **9**: 255–267. *f. 1–3*. 20 N 1925.
Experiments with *Valonia macrophysa*.

Ota, J. Continuous respiration studies of dormant seeds of *Xanthium*. Bot. Gaz. **80**: 288–299. *f. 1–4*. 30 N 1925.

Prankerd, T. L. The ontogeny of graviperception in *Osmunda regalis*. Ann. Bot. **39**: 709–720. *f. 1–3*. O 1925.

Record, S. J. Occurrence of intercellular canals in dicotyledonous woods. Trop. Woods Yale Univ. School For. 4: 17–20. 1 D 1925.

Reddick, D. Plant pathology. Bull. U. S. Bur. Education **1925**[4]: 39–43. 1925.

Ricker, P. L. Our Christmas greens—a real problem. Nat. Mag. **6**: 357–360. *illust.* D 1925.

Robbins, W. J., & Scott, I. T. Further studies on isoelectric points for plant tissue. Jour. Agr. Res. **31**: 385–399. *f. 1–3*. "15 Au" S 1925.

St. John, H. A critical consideration of Hagström's work on *Potamogeton*. Bull. Torrey Club **52**: 461–471. *f. 1*. "N" 18 D 1925.
Biographical note on J. O. Hagström by the editor, T. E. Hazen.

Sands, H. C. A micro dissection of the pachytene threads of *Tradescantia virginica* L. with observations on some aspects of mitosis. Jour. Gen. Physiol. **9**: 181–189. *f. 1* + *pl. 1*, 2. 20 N 1925.

Sebille, R. Contribution à la flore muscinale du Brésil. Deux espèces nouvelles de la famille des Hookeriacees. Rev. Bryol. **52**: 22–23. 1925.
Crossomitrium paulense and *Lepidopilidium proligerum*.

Shamel, A. D., Pomeroy, C. S., & Caryl, R. E. Bud selection in the Washington navel orange—IV. Progeny tests of limb variations of the ribbed strain. Jour. Hered. **16:** 415–422. *f. 11–14.* 7 D 1925.

Shull, G. H. The third linkage group in *Oenothera.* Proc. Nat. Acad. Sci. **11:** 715–718. 15 D 1925.

Sifton, H. B. Poison canals of *Cicuta maculata.* Bot. Gaz. **80:** 319–324. *pl. 17, 18.* 30 N 1925.

Skeen, J. R. Greensand as a source of potassium for green plants. Am. Jour. Bot. **12:** 607–616. *f. 1–4.* 18 D 1925.

Skottsberg, C. Juan Fernandez and Hawaii; a phytogeographical discussion. Bull. Bernice Pauahi Bishop Mus. 16: 1–47. 1925.

Spaulding, P., & Rathbun-Gravatt, A. Conditions antecedent to the infection of white pines by *Cronartium ribicola* in the northeastern United States. Phytopathology **15:** 573–583. *f. 1–5.* "O" 10 N 1925.

Spegazzini, C. Fanerogamas Argentinas. Rev. Argentina Bot. **1:** 75–86. *illust.* O 1925.
Several species, described as new.

Spegazzini, C. Ficomiceteas Argentinas nuevas o criticas. Rev. Argentina Bot. **1:** 87–93. O 1925.
Several species, described as new.

Spegazzini, C. Nota de teratologia. Caso de fillomania o viridificacion en la *Vachellia lutea* (Mill.) Speg. Rev. Argentina Bot. **1:** 73–75. O 1925.

Spegazzini, C. Uredineas Argentinas nuevas o criticas. Rev. Argentina Bot. **1:** 93–145. O 1925.
Many species, forms, and names, described as new.

Spegazzini, C. Ustilagineas Argentinas nuevas o criticas. Rev. Argentina Bot. **1:** 145–156. O 1925.
Several species, described as new.

Sponsler, O. L. X-ray diffraction patterns from plant fibers. Jour. Gen. Physiol. **9:** 221–233. *f. 1–4 + pl. 3.* 20 N 1925.

Stakman, E. C., Levine, M. N., & Griffee, F. Webster, a common wheat resistant to black stem rust. Phytopathology **15:** 691–698. *f. 1.* N 1925.

Standley, P. C. An enumeration of the Sapotaceae of Central America. Trop. Woods Yale Univ. School. For. 4: 1–11. 1 D 1925.

Species in *Lucuma* (5) and *Bumelia* (2), described as new.

Standley, P. C. New plants from Central America—IV, V. Jour. Washington Acad. Sci. **15:** 457–462; 472–481. 4 O, 19 D 1925.

Standley, P. C. A new United States weed: *Hymenophysa pubescens.* Science II. **62:** 509–510. 4 D 1925.

Standley, P. C. Orchid collecting in Central America. Ann. Rep. Smithsonian Inst. **1924:** 353–377. *pl. 1–26.* 1925.

Stevens, F. L. Hawaiian fungi. Bull. Bernice Pauahi Bishop Mus. 19: 1–189. *pl. 1–10.* O 1925.

Stevens, F. L. Plant disease fungi 1–469. *f. 1–407.* N. Y., 1925.

Stevens, N. E. The literature of plant pathology and the Plant Industry Catalog. Phytopathology **15:** 722–724. N 1925.

Stroman, G. N., & Mahoney, C. H. Heritable chlorophyll deficiencies in seedling cotton. Texas Agr. Exp. Sta. Bull. 333: 1–22. *f. 1–3.* Au 1925.

Tehon, L. R. A preliminary report on the occurrence and distribution of the common bacterial and fungous diseases of crop plants in Illinois. Illinois Nat. Hist. Surv. Bull. **15:** 173–325. *maps 1–112.* N 1924.

Tehon, L. R., & Daniels, E. Note on the brown leaf-spot of alfalfa. Phytopathology **15:** 714–719. *f. 1.* N 1925.

Genus *Thyrospora* described as new.

Tisdale, W. H., Taylor, J. W., Leukel, R. W., & Griffiths, M. A. New seed disinfectants for the control of bunt of wheat and the smuts of oats and barley. Phytopathology **15:** 651–676. *pl. 25–28.* "N" 10 D 1925.